Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

PUBLIC HEALTH REPORTS

VOL. 35 NOVEMBER 25, 1920 No. 48

A METHOD OF CLASSIFYING FAMILIES ACCORDING TO INCOMES IN STUDIES OF DISEASE PREVALENCE.[1]

By EDGAR SYDENSTRICKER and WILFORD I. KING, Statisticians, United States Public Health Service.

I. The Use of Income Facts in Studies of Disease.

In studies of disease prevalence and incidence, emphasis is being laid nowadays upon the possible influence of environmental conditions that formerly were given no more than cursory consideration. This tendency undoubtedly is in line with the realization that the occurrence of most diseases, especially those which are of the non-infectious type, is more or less intimately dependent, not upon a single condition or set of conditions, but upon the mass of interrelated conditions under which a population lives. Partly, at least, this is also due to the wider comprehension of the necessity of applying certain fundamental principles of statistical analysis to public health studies. One of these principles is, that before the effect of any single condition can be accurately evaluated, the possible effect of other conditions must be considered and measured.

This conception, however, has made the task of investigation and analysis much more difficult. With the idea of finding out *all* that there is to be known about the conditions that affect the prevalence of a disease, schedules for obtaining data often have been greatly amplified. In at least some collections of data relating to living conditions or relating to some one set of living conditions, such as housing, quite detailed descriptions for each individual or each family have been secured. Desirable as refinement of detail may be for the exact determination of the influence of some one factor, the student is likely to become bewildered and to lose himself in the mass of interrelated facts that often can not be analyzed statistically, or, if analyzed, yields indefinite results because of chance irregularities due to the minuteness of the subdivision of the data. He is driven by necessity, if he is to make any definite progress, to find some general, yet sufficiently accurate, expression representing some or most of the differences in living conditions of a population—an expression which he can use as an aid in eliminating extraneous influences before proceeding to the analysis of the specific condition which is suspected of playing an influencing or causative rôle.

---

[1] From Field Investigations of Pellagra, United States Public Health Service. Submitted for publication, Sept. 7, 1920.

Obviously, it is desirable that this general expression, this index of living conditions, should, for purposes of accuracy and convenience, be expressed in *numerical* form. This need is seen in the fact that too often otherwise carefully made epidemiological studies are marred by comparisons of groups within a specified population class defined by such indefinite terms as "in moderate circumstances" or as "poor," "fair," and "well-to-do," or even as "mill workers," "mechanics," "laborers," entirely ignoring the fact that one family of "laborers" may be prosperous while another is in extreme poverty. The desired index must then be both specific and commensurable, and the only single index yet discovered which meets these requirements and which also conveniently and accurately approximates the whole complex of conditions under which a family lives is family income. The reason for this is obvious. Whether or not nutritious diet, sanitary housing, adequate clothing, proper facilities for the care of children, opportunity for wholesome recreation, and sanitary neighborhood conditions can be enjoyed is determined mainly by the family's financial status. Ignorance of hygiene is more pronounced and more widespread among the "poor" than among the "moderately well-off" or the "well-to-do." The partnership of poverty and ill-health has become proverbial. Only recently, however, has it been afforded quantitative expression by the results of actual studies. Thus it has been found that among families of textile workers in South Carolina the rate of disabling sickness in the poorest class was 70 per 1,000 as against less than 19 per 1,000 in families financially better off; that among garment workers in New York City the proportion classed as poor in nutrition or as anemic or as affected with tuberculosis was definitely greater among those receiving the lowest annual incomes than among those who were better paid; that infant mortality bears an inverse relationship to the annual earnings of the father; that a rise in retail prices, unaccompanied by a commensurate increase in income (a situation characterizing certain wage-earning families in New York City), resulted in the restriction of the diet of these families in certain important respects, and is reported to have been reflected in an increased incidence of sickness as well as in a retardation of recovery from illness.[2]

---

[2] Reference may be made to the following studies:

Sydenstricker, Edgar, Wheeler, G. A., and Goldberger, Joseph, Disabling Sickness Among the Population of Seven Cotton-Mill Villages of South Carolina in Relation to Income: Public Health Reports, Nov. 22, 1918.

Warren, B. S., and Sydenstricker, Edgar, Health of Garment Workers—Relation of Economic Status to Health: Public Health Reports, May 26, 1916.

Duke, Emma, and others, Infant Mortality Studies: Children's Bureau, U. S Dept. of Labor.

Harris, L. I., Some Medical Aspects of the High Cost of Living: American Journal of Public Health July, 1919.

The instances just cited illustrate the fact that income is, for many purposes, a satisfactory index of the general quality of the environment. Since it is a usually accepted fact that bad environment favors the development of disease, it is not at all surprising that low income is commonly associated with a high general morbidity rate. If sickness is thus frequently related to income, it becomes imperative in the study of disease conditions among any segment of the population to take into account the economic condition of the respective families composing it. In dealing with data previously collected, this rarely can be accomplished, owing to the fact that existing records of sickness almost never give any accurate information concerning the income status of the patients. Therefore, until such records are prepared, attempts to discover the factors giving rise to or affecting illness will in many instances be foredoomed to failure. Without such information, for example, it is impossible to decide whether a high sickness rate from any specific disease among a certain class of workers is due to injurious effects of their occupation or to their unsatisfactory living conditions at home. A reasonably accurate determination of the income status of such workers is, then, an essential prerequisite to any study of the supposedly deleterious effect of some specific condition affecting the persons in a given trade. Mere rough guesses concerning the economic conditions of various workers are unsatisfactory. Rather than proceed to record estimates of this nature or collect meaningless or (what is worse) misleading data relating to economic status, it is far preferable to omit these estimates entirely from consideration and to confess the omission.

To ascertain the income of the ordinary family with a reasonable degree of accuracy is entirely feasible, provided that the field agent is equipped with a correctly constructed questionnaire and is himself well trained in its use, and provided also that he can secure the cooperation of some responsible member of the family and has sufficient time for careful questioning. Experience has shown that, with an adequate appropriation, the other possible difficulties offer no real obstacles to the collection of data from which the family income for a given period may be computed with a satisfactory degree of accuracy.

II. Various Methods Heretofore Used in Classifying Families According to Income.

Upon the assumption, therefore, that the amount of family income for a specified unit of time (year, month, week) has been ascertained, it is the purpose of this paper to suggest a method by which families can be classified and compared upon this basis.

In economic studies and investigations, several methods of classification have long been employed. The usual method is to classify families on the basis of total income into such groups as "less than

$500," "$500 to $699," "$700 to $899," etc., per annum. Only where the range of income among a population is large and the population is well distributed throughout the range can such a classification lead to even moderately accurate comparisons. This is true because families with very similar total incomes may differ decidedly in—

(1) Size (the number of persons dependent upon family income) and
(2) Composition, with respect to the—
    (*a*) Sex, and
    (*b*) Age

of their members. Manifestly the Clark family with an annual income of $1,800 and consisting of only Clark and his wife ought not to be put into the same income class as the Smith family, which, although it also has an annual income of $1,800, is composed of Smith, his wife, and five dependent children. The chances are quite considerable that if either family must make sacrifices in diet or clothes or live in an insanitary house or an undesirable community environment, it will be the Smiths and not the Clarks.

A second method is to divide total family income for each family by the number of persons in the family and to obtain thereby the *per capita* family income. The objection to this is that while it takes into account the *size* of the family, it leaves out of consideration differences among families as to the *sex* and *age* of their members. The children in the Smith family may be youngsters under 12 years of age, while Brown, with the same number of persons in his family, may have to support a mother-in-law, a son in high school, and a daughter receiving callers, besides two young children. In spite of what a specific Mrs. Brown may do in the way of careful management, the Browns as a class are apt to suffer in comparison with the Smiths or the Clarks, even though all receive the same total income.

A third method which has been employed in at least one important economic investigation in the United States is to select for study only those families which are exactly alike or quite similar in size and composition.[3] While this method partially eliminates the necessity of considering differences among families arising from size, or from sex and age composition, it seriously limits the number of families available for comparison and study, and thus increases materially the task of collecting an amount of data sufficient to give statistical regularity. Furthermore, in studies of disease incidence or prevalence, this method is rarely practicable, for the reason that a fundamental desideratum is the collection of data relating to persons both affected and not affected by the disease, regardless of the size or other characteristics of the family. Frequently, also, it is necessary to include in one's survey an entire community, or at least numerous specific "samples" of the population of a community. Under such conditions manifestly it is impossible to pick families of a certain size and of a specified sex and age composition.

---

[3] Edward Ducpetiaux, a pioneer in the collection of family budgets, proposed (1855) to select only those families which consisted of father, mother, and 4 children, aged, respectively, 16, 12, 6, and 2 (Budgets Economiques des Classes Ouvrières en Belgique, Bulletin de la Commission Centrale de la Statistique; Vol. VI). The United States Bureau of Labor, under the Commissionership of Carroll D. Wright, in its extensive cost of living study in 1901, used a "normal" family as a basis for comparison, defining such a family as one consisting of father, mother, and not over 5 children, who should be under 14 years of age and no other members (Twenty-third Annual Report of the Commissioner of Labor, 1903). In this study 25,440 families were included; but only 11,156, or less than half, came within Wright's definition of a "normal" family.

III. The Income-Per-Unit Method.

A fourth method is one which the writers here present, after developing it for use in connection with the part of the pellagra investigations of 1917 dealing with the relation of the disease to economic conditions in textile communities of South Carolina.[4]

Briefly stated, this method is to reduce to some common denominator, or unit, persons of either sex and any age so that families of different size and sex and age composition can be expressed as a number. Thus if an adult male of a given age = 1.0 unit, and adult female of a given age = 0.8 of a unit, a boy aged 10 = 0.5 of a unit, a family consisting of these individuals could be expressed as the sum of the units, or 2.3. The next step is to divide the amount of family income by the number of units in the family. If one family had a monthly income of $120, its monthly income per unit would be $\frac{\$120}{2.3} =$ $52.17. Any family or group of families for which the total income and the sex and age of each individual member are known may be dealt with similarly.

The principle of the method is simple and the general concept is, of course, not new.[5] If, however, the method is to yield dependable income classifications, the choice of a basis for classification is of fundamental importance, the unit chosen must be definite, and, above all, the scales must be reasonably accurate.

---

[4] See Goldberger, J., Wheeler, G. A., and Sydenstricker, E., A Study of the Relation of Family Income and Other Economic Factors to Pellagra Incidence in Seven Cotton-Mill Villages of South Carolina in 1916: Public Health Reports, Washington, D. C., Nov. 12, 1920, pp. 2673-2714, Reprint No. 621.

[5] Prior to its application in studies of pellagra (see Sydenstricker, E., Wheeler, G. A., and Goldberger, J., Disabling Sickness Among the Population of Seven Cotton-Mill Villages of South Carolina in Relation to Family Income: Public Health Reports, Nov. 22, 1918) its use had been confined to dietary comparisons. As early as 1795 the Rev. David Davies, an English writer on conditions of labor, mentioned a scale of this kind which had been proposed by Foley for food requirements of persons of different ages. The method, so far as applied to evaluating food requirements, was elaborated by Atwater in the United States in the form of a scale of energy requirements, the first published suggestion of such a scale by Atwater being in 1892 in the Annual Report (1891) of the Connecticut Agricultural Experiment Station. This scale, based not solely upon the budgetary records of individuals, but also upon calorimeter studies, with later modifications, was used in various dietary studies of the United States Department of Agriculture, with which Atwater later became connected. About the same time Engel, in Europe, elaborated the method in a different manner. Engel, in 1895, took as the basis for comparing persons of different sex and age the weight per centimeter of height, and, using the average for a large number of persons, proposed that the food requirements of a child in its first year be considered a unit or "quet" (so named after Quetelet), and that for each additional year of age up to 25 there be an increased requirement of one-tenth of a quet (Lebenskosten Belgischer Arbeiterfamilien, Bulletin de l'Institute Internationale de Statistique, IX). Other students have employed variations of Atwater's and Engel's method, as, for example, Rowntree in his classic study of poverty (Rowntree, F. Seebohm, Poverty, A Study of Town Life, Chapter VIII, 1901). Atwater's plan of expressing food requirements of persons of different sex and age in terms of the requirements of adult males rather than in those of a child has become universal.

In the analysis of the incidence of disabling sickness and of pellagra in relation to family income in certain textile communities in South Carolina in 1916 it was found that the usual methods of classifying families according to income were too inaccurate. All of the families under consideration were families of mill operatives and thus received wages which fell within a relatively narrow range. Casual observations would lead to placing them all in one income class. A more refined basis for classifying them was necessary if the rather wide differences in income which actually existed within this group of families were to be revealed. In the absence of a better common denominator, the Atwater scale of food requirements was used in the analysis of the 1916 data.[6]

Comparison of the relative variations, according to age, of estimated individual expenses for all purposes among members of southern cotton-mill workers' families (U. S. Bureau of Labor, 1911) with that for food requirements (Atwater).

Age in years.	Male.		Female	
	Individual expenses (U. S. Bureau of Labor).	Food requirements (Atwater).	Individual expenses (U. S. Bureau of Labor).	Food requirements (Atwater).
Adult (over 16)	100	100	89	80
15-16	85	90	79	80
13-14	72	80	67	70
12	61	70	57	60
10-11	56	60	59	60
6-9	45	50	46	50
2-5	34	40	35	40
Under 2	26	30	26	30

NOTE.—The individual expenses estimated were for food (estimated by the U. S. Bureau of Labor according to the Atwater scale), clothing, medical attendance and medicines, insurance, amusements, tobacco, and school books (Report on Condition of Women and Child Wage-Earners in the United States, Vol. XVI; Family Budgets of Typical Cotton-Mill Workers, by Wood F. Worcester and Daisy Worthington Worcester, 1911, p. 150).

The basis thus suggested was employed by Prof. Ogburn in an analysis of cost of living data in the District of Columbia, which was collected by the Bureau of Labor Statistics, U. S. Department of Labor (Ogburn, William F., Analysis of the Standard of Living in the District of Columbia in 1916: Quarterly Publication of the American Statistical Association, XVII, 385, June, 1919).

---

[6] The use of this method has been described in a previous publication (Sydenstricker, Edgar, Wheeler, G. A., and Goldberger, Joseph, Disabling Sickness Among the Population of Seven Cotton-Mill Villages of South Carolina in Relation to Family Income: Public Health Reports, Nov. 21, 1918). As pointed out in this publication, the assumption in the use of this scale was that the expenditures for individuals varied according to sex and age in the same proportion as their food requirements. The assumption was by no means as accurate as could be desired; in its favor, however, it was said that since family expenditures in the great majority of cases in the population studied equaled total family income, and since food expenditures were nearly half (among poorer families considerably more than half) of total expenditures, a scale based even on food requirements alone was obviously very much more accurate than one omitting any consideration whatsoever of the number, sex, and age of individuals composing the families to be compared with respect to income. Before using the Atwater scale for this purpose, several published estimates of the cost of maintenance for individuals of various ages were examined. These estimates were based, in several instances, upon the results of investigations of actual expenditures of individual members of families. Using the estimated expenditures for an adult male as 100, the estimates for individuals of other ages of either sex was expressed relatively and compared with the Atwater scale. It appeared that, in most instances, the scales were fairly similar. The table here presented, computed from probably the most pertinent data available, indicated the relative cost of maintenance (at "a fair standard of living") for a year of individuals of various ages as estimated for southern cotton-mill workers by the United States Bureau of Labor in 1911, in comparison with the Atwater scale for the food requirements of individuals engaged in moderate muscular work.

Although it was not felt that any significant degree of error was involved in the use of the Atwater scale for this purpose, it seemed desirable to utilize a basis which would be more inclusive of the economic needs of the individual than the need for food alone. Accordingly, it was determined to use as the basis for classifying families a unit which would express as far as possible the relative differences in *all economic wants* among persons of different sexes and ages.

With this purpose in view, plans were made in 1916 to collect during the following year from a sufficient number of representative families such data as would show, with a reasonable degree of accuracy, the true relationship existing between total expenses incurred for all purposes for persons of various ages and both sexes. It was felt that correct ratios of this sort would certainly increase the possibility of measuring accurately the relative well-being of the families dealt with in the more extensive pellagra studies of 1917, especially since the difference between their respective incomes and expenditures was rarely considerable. In 1917 this study was made. While it was a necessary part of the investigations of pellagra, the results of this incidental study, as well as of certain statistical analyses of data collected in 1916 and 1917 from the point of view of food requirements of persons of different sex and age, will, it is believed, prove helpful not only for this specific purpose, but also as aids in future investigations in which family income is a factor of some importance.

These results are presented in the following pages. In analyzing the data the problem was found to consist of two parts: First, the derivation of correct curves showing food expenditures, and, second, the obtaining of similar curves for other expenditures. The reason that this division of the problem was necessary lay in the fact that the food used, including that purchased and that produced at home, was recorded only for the family as a whole, and it was entirely impracticable to secure separate records for individuals. On the other hand, expenditures for such articles as clothing, medical care, tobacco, amusement, etc., might actually be estimated for the different individuals in the family.

1. DIFFERENCES IN EXPENDITURES FOR FOOD AMONG PERSONS OF DIFFERENT SEXES AND VARIOUS AGES—THE "FAMMAIN" SCALE.

The first step undertaken was to test out the 1916 apportionment of food according to the Atwater scale to see whether this apportionment corresponded with the actual values of food purchased. The 1916 study was preliminary in its nature, and home-produced food had not been evaluated therein. As a result, the comparison was actually one of the money value of purchased food with food requirements in calories. The result of the test was to show a reasonably close correspondence of the Atwater scale with the relative food purchases except in one respect– the Atwater scale rated all adults on the same basis, while the 1916 budgets indicated that purchases of food made for adults above the age of 35 were materially smaller than those made for adults from 19 to 35 years of age. Although it was suspected that this divergence was due to incompleteness in the Atwater scale, the fact was kept in mind that there might really exist a difference between food needs in calories and money values of food purchased, for it should be remembered that the new scale was so constructed as to represent a distinctly different concept from that of the Atwater scale. Money value was substituted for calories, and the actual supply obtained for consumption was used in place of the amount which the system requires for adequate nourishment.

Moreover, it is well to keep in mind the fact that the new scale is designed to portray *demands* for food rather than *actual purchases* thereof. Purchases are made for varying groups of individuals at irregular intervals. Demand is fairly constant. The concept of demand, however, is so largely psychological that it can only be measured indirectly. We can easily measure the value of food actually purchased or raised for consumption, and the average value for a considerable number of families doubtless varies proportionately to demand. The variations for different ages and sexes in the *value* of food are likewise persumably about the same as the variations in the *demand* for food; hence the relative curve representing the value of home produced food plus purchases can, without much probability of serious error, be also used as representing the relative food demand according to sex and age.

There being such a wide departure from the original meaning, it seems undesirable to adapt the term "adult male unit" to the new concept, since that term is already identified with a perfectly specific idea. It therefore appears advisable to coin a new term, inasmuch as no existing word seems to cover the idea at all accurately. The unit has accordingly been called a *fammain,* the word being a rough abbreviation of *food expense for adult male maintenance.* The *fammain* may be defined for any given class of people as a *demand for food of a money value equal to that demanded by the average male in the given class at the age when the expense for his food reaches a maximum,*[7] or, more briefly, the unit of food expense for adult male maintenance.

It was felt that the 1916 *fammain* scale might be materially inaccurate inasmuch as it was based upon budgets derived from only about 500 families and the number of persons in the higher age classes was quite limited. It was therefore determined to apply this scale to the larger mass of data collected in 1917. If accurate, the food expense per *fammain* evidently ought to show no tendency to vary, whatever the age or sex composition of the family. Without describing at length the rather detailed statistical processes necessary,[8] it may be stated briefly that variations in family income were first eliminated by dividing the families roughly into classes of somewhat similar income. Each income class was dealt with separately. The results of the test when applied to about 1,000 families showed that the 1916 study had rated females very slightly too low and that the older people had been rated materially too low. Necessary adjustments were made for these errors and new scales derived. In order

---

[7] The scales here presented were derived from a study of men and women engaged in what is assumed to be moderate muscular work. In an industry in which the men only are engaged in heavy work the ratios for women and children would be reduced somewhat from those here given.

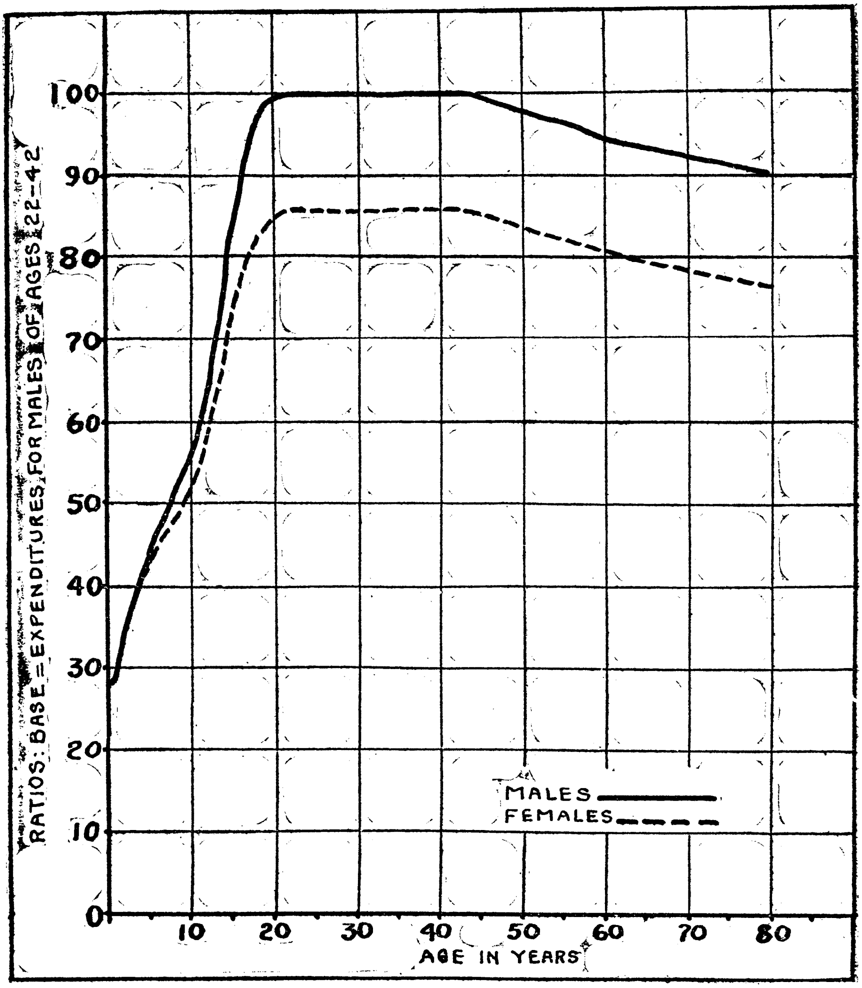

FIG. 1.—Relative cost of food for persons of each sex and of different ages, as determined from records of food supplies for 1,500 families in South Carolina textile-mill villages in 1916 and 1917. (See Table I: Table of *fammains*.)

---

[8] These processes will be described in greater detail in another paper.

to make sure that the adjustments, which were somewhat intricate, had accomplished the purpose intended, the number of *fammains* according to the adjusted scales was computed for each family. Again the test was made to see whether the average expense per *fammain* showed a tendency to increase or diminish as the age and sex composition of the family changed. Budgets from about 1,500 families were used in this verifying process. It was found that the ratio of food expenditures of females to males had been determined as accurately as the data permitted. A slight additional upward adjustment was necessary in the case of persons over 34 years of age. By use of these finally adjusted scales the number of *fammains* in each family was again computed and applied as before to a somewhat different set of families at a different season of the year. No adjustments proved necessary in this instance. It is believed, therefore, that the scale as herewith presented (Table I, Figure 1) represents with a fair degree of accuracy the normal relative expenditures for food of persons of different sexes and ages in certain typical cotton-mill villages of South Carolina in 1916 and 1917, the adults generally being engaged in what may be described as "moderate muscular work," though in some cases the activity might be less than that phrase would imply.

TABLE I.—*Table of fammains—relative cost of food for persons of different sexes and ages as determined from records of food supplies for 1,500 families in South Carolina textile villages in 1916 and 1917.*

[Base: Males, ages 21 to 44.]

Age in years.	Male.	Female.	Age in years.	Male.	Female.
Under 1	$0.28	$0.27	41	$1.00	$0.86
1	.30	.29	42	1.00	.86
2	.35	.34	43	1.00	.86
3	.38	.37	44	1.00	.85
4	.40	.40	45	.99	.85
5	.44	.43	46	.99	.85
6	.46	.45	47	.99	.85
7	.48	.46	48	.99	.84
8	.51	.48	49	.98	.84
9	.53	.49	50	.98	.84
10	.56	.52	51	.98	.83
11	.59	.54	52	.97	.83
12	.64	.58	53	.97	.83
13	.69	.62	54	.97	.82
14	.77	.66	55	.96	.82
15	.84	.72	56	.96	.82
16	.90	.76	57	.96	.82
17	.94	.80	58	.95	.81
18	.97	.82	59	.95	.81
19	.98	.84	60	.95	.81
20	.99	.85	61	.94	.80
21	1.00	.85	62	.94	.80
22	1.00	.86	63	.94	.80
23	1.00	.86	64	.94	.79
24	1.00	.86	65	.93	.79
25	1.00	.86	66	.93	.79
26	1.00	.86	67	.93	.79
27	1.00	.86	68	.93	.79
28	1.00	.86	69	.93	.78
29	1.00	.86	70	.92	.78
30	1.00	.86	71	.92	.78
31	1.00	.86	72	.92	.78
32	1.00	.86	73	.92	.78
33	1.00	.86	74	.92	.78
34	1.00	.86	75	.91	.77
35	1.00	.86	76	.91	.77
36	1.00	.86	77	.91	.77
37	1.00	.86	78	.91	.77
38	1.00	.86	79	.91	.77
39	1.00	.86	80	.90	.77
40	1.00	.86			

The Atwater scale deals with consumption in *calories*, while the scale just described represents *money value* of the food supply. Unless it should prove true that for a certain sex and age the cost of one calorie is, on the average, greater than that for persons of different sex and age, it necessarily follows that differences between the Atwater and the *fammain* scales can not be attributed to differences in the units used in their formation. In order to determine the facts in this regard, families were divided into classes according to the average sex and age of their members, and the cost of food per calorie was computed for each class. It was found to show no distinct tendency to vary in any way. We must conclude, therefore, that the *fammain* scales are equally serviceable to show either the relative money cost of the food supply or the relative calories contained in the food supply for each age in both sexes.[9]

Presumably, whether measured in terms of calories or of cost, the quantity of food actually consumed by members of any given income class tends to vary within that class principally in proportion to the basal requirements of the members (under given conditions of muscular exertion). It is quite possible, in fact, probable, that other conditions may be present and cause divergencies from the basal requirements curve. The striking similarity, however, of the Atwater and *fammain* scales for those ages for which they are comparable suggests that such slight divergencies as are actually shown are due rather to methods of computation than to any real differences in the facts which they are intended to set forth.

This scale of *fammains* having been thus computed, it is now possible to make a logical comparison of the relative requirements for food expense for the members of different dietary groups, a dietary group being defined as those persons ordinarily eating from a common food supply. Each member of the dietary group is rated at his or her particular fraction of a *fammain*. These fractions are added to give the number of *fammains* in the dietary group. The total cost of food for the dietary group is then divided by the number of *fammains* in the group in order to obtain the expense for food per *fammain*. A comparison of these relative expenses per *fammain* for food gives, from the standpoint of cost, a fairly accurate picture of abundance or scarcity of food supply in the families under consideration.

2. DIFFERENCES IN EXPENDITURES FOR ALL PURPOSES AMONG PERSONS OF DIFFERENT SEXES AND AGES—THE "AMMAIN" SCALE.

But food expense is evidently only an important fraction of the family budget and is, when taken by itself, an insufficient basis for an accurate classification of a family in the scale of economic well-being. It is, therefore, necessary in planning any such comparison to consider expenditures not only for food, but for other articles as well. Next to food, clothing is the really heavy expense among the cotton-mill families. It is, of course, bought for the use of individual persons. Similarly, tobacco, soft drinks, entertainment, etc., are individual expenses. It was determined, therefore, to obtain for the preceding 12 months, estimates from various housewives in the villages as to the entire family budget, except food supply (which already had been accounted for), and to apportion to the individuals using them as large a fraction as possible of the items obtained by the family.[10]

---

[9] It is intended to consider this point more at length in a later paper.

Following this plan detailed statements of expenditures for the preceding 12 months were obtained in 1917 from some 300 families.

TABLE II.—*Relative expenditures for persons of different sexes and ages for articles purchased for individual use, as shown by budgets of 140 families in South Carolina textile villages in 1916 and 1917.*

(Base: Males, ages 24-25.)

Age in years.	Male.	Female.	Age in years.	Male.	Female.
Under 1	0.11	0.11	41	0.80	0.44
1	.13	.13	42	.79	.43
2	.16	.16	43	.79	.41
3	.17	.17	44	.78	.40
4	.19	.18	45	.78	.38
5	.20	.19	46	.77	.37
6	.22	.21	47	.76	.36
7	.24	.23	48	.76	.35
8	.26	.25	49	.75	.35
9	.28	.27	50	.74	.34
10	.31	.30	51	.73	.33
11	.33	.33	52	.71	.33
12	.35	.37	53	.69	.32
13	.40	.40	54	.67	.32
14	.46	.44	55	.64	.31
15	.55	.48	56	.62	.30
16	.65	.57	57	.61	.30
17	.77	.60	58	.60	.29
18	.86	.61	59	.58	.29
19	.92	.63	60	.57	.28
20	.95	.63	61	.56	.28
21	.96	.63	62	.55	.27
22	.98	.62	63	.54	.27
23	.99	.62	64	.53	.27
24	1.00	.61	65	.52	.26
25	1.00	.60	66	.51	.26
26	.99	.60	67	.51	.26
27	.97	.59	68	.50	.26
28	.95	.59	69	.49	.26
29	.94	.58	70	.49	.26
30	.92	.58	71	.48	.26
31	.91	.57	72	.47	.25
32	.89	.55	73	.47	.25
33	.88	.54	74	.46	.25
34	.87	.52	75	.46	.25
35	.85	.50	76	.45	.25
36	.84	.49	77	.45	.25
37	.83	.48	78	.44	.25
38	.82	.47	79	.44	.25
39	.82	.46	80	.43	.25
40	.81	.45			

Food expenditures were calculated from records previously secured and were added in. Information concerning the family income was already at hand. Total reported income and expenditures were therefore compared for each family. When the two failed to check within 15 per cent, the error was considered so large as to render the schedule worthless and it was rejected. One hundred and forty schedules, representing 672 individuals, were retained, most of these having errors under 8 per cent. All apportionable expenditures for each individual were then compared with his or her sex and age, averages were computed, and a curve was derived for each sex. These curves were smoothed and the indices derived therefrom were combined with those of the corresponding *fammain* scale, weights being applied in proportion to the actual expenditures for food as compared to the other purposes considered. The combined

---

[10] Since rent was in most cases a very small item of expense, the proportion of total expenditures for the entire family which went for individual purposes, including food, was very large—over 90 per cent.

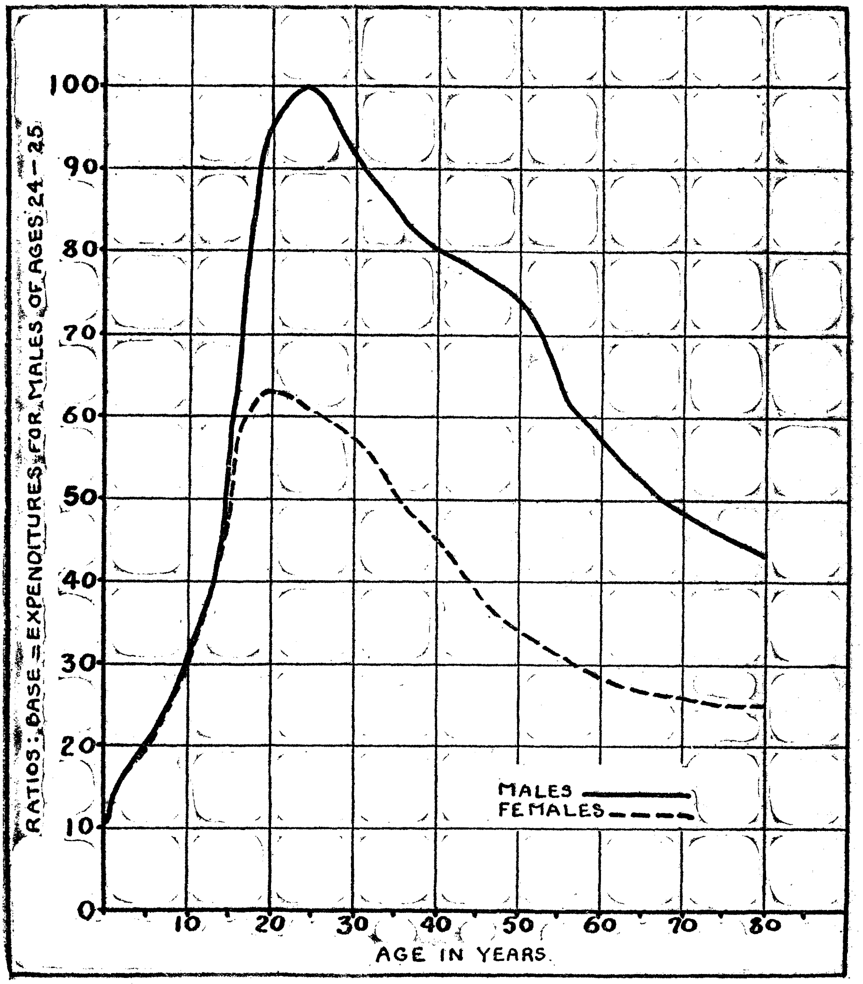

FIG. 2.—Relative expenditures for persons of each sex and of different ages, for articles purchased for individual use, as shown by budgets of 140 families in South Carolina textile mill villages in 1916 and 1917. (See Table II.)

scales are intended to represent approximately the *relative demands* in terms of money value for food, clothing, and miscellaneous individual requirements, all combined. Expenses incurred for these articles together constitute about 89 per cent of the total family expenditures,

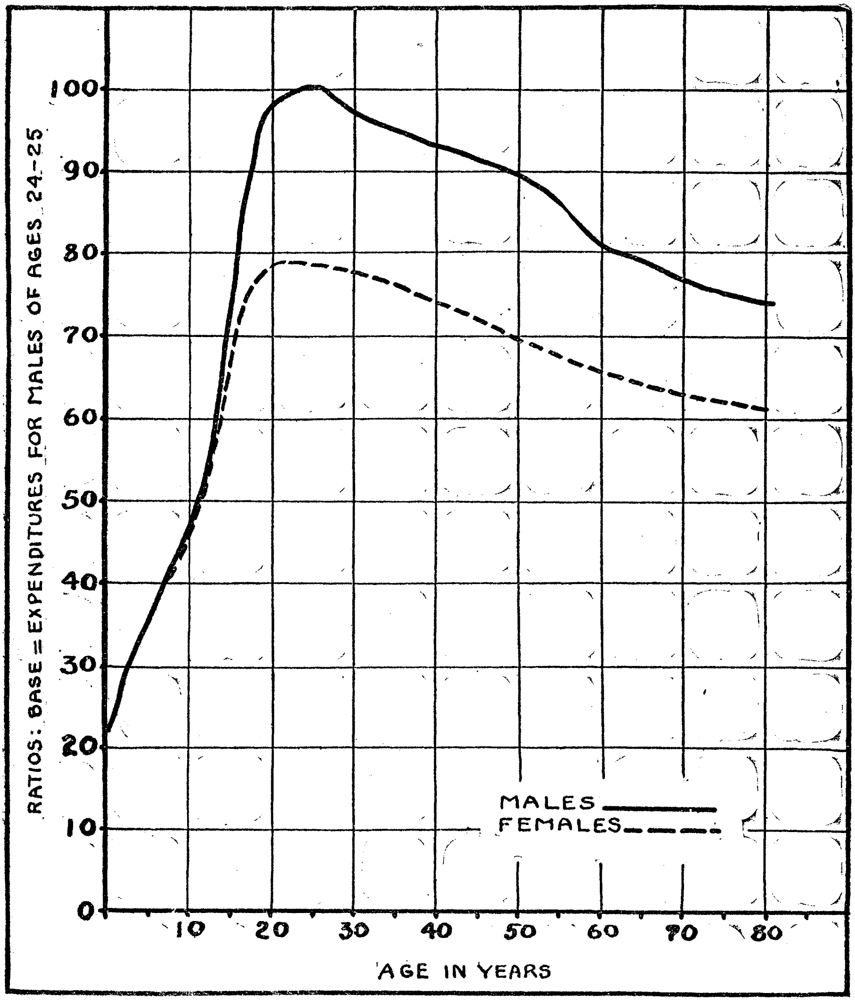

FIG. 3.—Relative expenditures for persons of each sex and of different ages, for food and articles purchased for individual use, as shown by records of food supplies and budgets of families in South Carolina textile-mill villages in 1916 and 1917. (See Table III: Table of *ammians*.)

hence it seems certain that the scale is fairly representative of all expenses for the families considered.

This scale is evidently based upon a unit similar to that of the *fammain*, differing therefrom only in that it includes also a number of other important items instead of food alone. It may be denominated as *ammain* (this being an abbreviation for total expense for *adult male maintenance*) and defined, for any given class of people, as *a gross demand for articles of consumption having a total money value equal to that demanded by the average male in the given class at the age when his total requirements for expense of maintenance reach a maximum*, or, more briefly, the unit of total expense for adult male maintenance.

Table II and Figure 2 show the variations in expenditures for persons of different sexes and ages for articles purchased for individual use, as determined from the budgets of 140 families. Table III and Figure 3 present the final *ammain* scale for both sexes, showing the variations in the expense of maintenance (including food as well as articles purchased for individual use). A condensed table of *ammains* (Table IV) is suggested for use where refined classifications are unnecessary or impracticable.

TABLE III.—*Table of ammains—Relative expenditures for persons of different sexes and ages for food and articles purchased for individual use as shown by budgets of families in South Carolina textile villages in 1916–17.*

[Base: Males, ages 23 to 26.]

Age in years.	Male.	Female.	Age in years.	Male.	Female.
Under 1	0.22	0.22	41	0.93	0.74
1	.24	.24	42	.93	.73
2	.28	.28	43	.92	.73
3	.31	.31	44	.92	.72
4	.33	.33	45	.92	.72
5	.35	.35	46	.91	.71
6	.38	.38	47	.91	.71
7	.40	.40	48	.90	.70
8	.42	.41	49	.90	.70
9	.44	.43	50	.89	.69
10	.47	.45	51	.89	.69
11	.50	.48	52	.88	.69
12	.54	.51	53	.87	.68
13	.59	.55	54	.86	.68
14	.66	.60	55	.85	.67
15	.74	.65	56	.84	.67
16	.81	.71	57	.83	.67
17	.88	.74	58	.83	.66
18	.93	.76	59	.82	.66
19	.96	.78	60	.81	.66
20	.98	.78	61	.81	.65
21	.99	.79	62	.80	.65
22	.99	.79	63	.80	.65
23	1.00	.79	64	.79	.65
24	1.00	.79	65	.79	.64
25	1.00	.79	66	.78	.64
26	1.00	.78	67	.78	.64
27	.99	.78	68	.78	.63
28	.98	.78	69	.77	.63
29	.98	.78	70	.77	.63
30	.97	.78	71	.76	.63
31	.97	.77	72	.76	.63
32	.96	.77	73	.76	.63
33	.96	.77	74	.75	.62
34	.95	.76	75	.75	.62
35	.95	.76	76	.75	.62
36	.94	.76	77	.75	.62
37	.94	.75	78	.75	.62
38	.94	.75	79	.74	.62
39	.93	.74	80	.74	.62
40	.93	.74			

TABLE IV.—*Table of ammains for age groups based on Table III (suggested for use in less refined classifications of families according to income).*

Age group.	Male.	Age group.	Female.
Under 2	0.2	Under 2	0.2
2 to 4	.3	2 to 4	.3
5 to 9	.4	5 to 9	.4
10 to 12	.5	10 to 12	.5
13	.6	13 to 14	.6
14 to 15	.7	15 to 18	.7
16	.8	19 to 36	.8
17 to 18	.9	37 to 64	.7
19 to 35	1.0	65 and over	.6
36 to 55	.9		
56 to 75	.8		
75 and over	.7		

IV. Income Classification by the "Ammain" Method.

The application of this method is a matter of simple arithmetic, provided the data are at hand. For the sake of clearness its use is outlined below:

1. Data required:
    - (*a*) Income of the family as a whole for a given period.[11]
    - (*b*) Sex and age of each person subsisting from family income.
2. Procedure:
    - (*a*) From the table of *ammains* (Table III) ascertain the fraction of an *ammain* for each person subsisting from family income.
    - (*b*) Obtain the sum of these fractions—i. e., the number of *ammains* composing the family.
    - (*c*) Then

$$\frac{\text{Family income}}{\text{Number of } ammains \text{ in family}} = \text{Family income per } ammain.$$

Illustration.

Family.	Monthly family income.	Sex and age of each individual member of family.		Equivalent in *ammains*. (See Table III.)	Monthly family income per *ammain*.
		Sex.	Age.		
Family A	$100	Male	25	1.00	$48.31
		Female	23	.79	
		Male	2	.28	
				2.07	
Family B	$100	Male	50	0.89	$33.11
		Female	45	.72	
		Male	16	.81	
		Female	14	.60	
				3.02	
Family C	$200	Male	60	0.81	$53.68
		....do	33	.96	
		Female	30	.78	
		....do	27	.78	
		Male	7	.40	
				3.73	
Three families as a group	$400			8.82	$45.35

---

[11] The accuracy of the data relating to income is, of course, fundamental. The *degree* of accuracy required naturally depends upon the desired exactness in comparing families or groups of families. It may be noted that, in calculating data as to family income, it is important to include income from *all* sources (wages of all wage-earning members not paying board, value of home-produced foods, receipts from boarders and lodgers, etc.), and to consider only *net* income as the basis for classification (i. e., after deducting cost of boarders and lodgers, cost of home-produced foods, etc.)

The foregoing illustration also serves to suggest the value of such a method as has been outlined. Comparing family A and family B with respect to income, it is seen that if the family income be taken as a basis, there is no difference indicated in their status, since each has an income of $100 per month. But, taking into account the differences in size and sex and age composition, family B is distinctly less well off than family A. Similarly, family C on the basis of family income has twice the income of either family A or family B. But taking into account the differences in size and sex and age composition, family C has but 62 per cent greater income than family B and only 11 per cent greater income than family A.

Groups of families can be compared in the same way by dividing the sum of the incomes for each group by the number of *ammains* in each group.

It is believed that the use of the above plan in the manner just illustrated presents a satisfactory method of classifying families according to income, thus providing for the essential prerequisite to accurate comparison and analysis from the point of view of economic status. In dealing with the population actually studied, we feel that the specific *ammain* scale herewith presented (Table III) may be applied to produce results of a rather high degree of accuracy.

It must not be assumed, however, that these particular scales are to be regarded, in any way, as the final word in this matter. They are only supposed to be fair approximations of conditions as they exist in South Carolina mill villages. It is highly probable that a study among other classes of people in other communities would produce somewhat different results. It should also be borne in mind that the scales here given were mainly derived from studies of incomes of families and may, perhaps, not fairly represent the situation of individuals living independently. Within such families the relative differences in expenditures for persons of different sexes and ages were found to be similar in groups of families with low and high incomes in the population studied. It is, however, quite possible that in a population having much higher incomes or widely different customs, marked dissimilarities might be found. In the mill villages, for example, women spend for clothing less than two-thirds as much as men. Presumably among the wealthy, this ratio might be reversed. Differences might be found, likewise, in other types of expenditure. In the case of food and many other staple articles, the *relative* expenditures probably are about the same for all classes. These staples dominate the budget for the great mass of the people; hence, for the vast majority of the population it is improbable that especially derived scales would differ widely from those representative of the cotton-mill villages.

It is, of course, desirable that similar scales be worked out for as many different sections of the population as possible; but, to most private investigators, the cost of collecting data for derivation of such scales is prohibitive. The belief is ventured that, in most cases, such a special study is not essential, as the scales here presented probably will not give rise to serious errors when applied to other sections of the population—especially to other wage-earning groups. It is practically certain that results derived by the use of these scales would, at least, be decidedly superior to those obtained by classifying families on the basis of net income for the family as a whole, without considering its size and composition, or even by figuring the net per capita income for each family.

ONE OR SEVERAL SPECIES OF MALARIA PARASITES?

A REVIEW OF RECENT WORK BEARING ON THIS QUESTION.

By BRUCE MAYNE, Biologist, United States Public Health Service.

The treatment of malarial fevers has been based partially on the classification of the types of the disease. The intelligent physician varies the specific treatment on the basis of microscopical findings and clinical symptoms. Therefore, the aid of the microscope must be sought in making a final decision. The differentiation of the various types of malaria plasmodia has been assumed by the clinician, the zoologist taking a subordinate part in the decision pertaining thereto. Possibly this may explain the confusion of the status of the parasitology of this disease. It is believed that the question whether the *Plasmodium* of malaria is a plural organism or a single polymorphic organism capable of causing one set of symptoms at one period and a different set of symptoms at another period in its life history is of more than academic interest. Assuming, then, that the problem is of sanitary importance, the matter is here given some consideration.

Although it has been generally accepted that the three species of *Plasmodium*, namely *P. vivax*, *P. falciparum*, and *P. malariæ* are distinct, the question of the complete transformation of the parasites of malaria has recently assumed much prominence in the literature of malariology. During the World War this question was given renewed interest through observations made on troops infected in the Balkans and subsequently repatriated. With the notable exception of the opinions of Laveran, the views upholding the unity of the species of *Plasmodium* were for the most part hastily constructed, and the recent additions to the literature give evidence of incomplete observations such as only war conditions could warrant.

Guided by the consensus of opinion of conservative workers in parasitology, it is safe to assume the following as the status of the